FINAL REPORT

Respond Formulation Effects on Localized Dry Spot Incidence and Putting Green Moisture

a research report submitted to E. Marker A/S

by

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Background: Previous research on wetting agent efficacy, when applied to sand-based putting greens, has focused primarily on evaluating water drop penetration times (WDPT) or visual localized dry spot (LDS) symptoms. This research has demonstrated that most commercially available wetting agents are effective in reducing soil hydrophobicity and decreasing LDS symptoms. However, many golf course superintendents are also concerned about how wetting agent application will effect soil moisture distribution throughout the rootzone. Golf course superintendents commonly state that some wetting agents move water rapidly through the rootzone while other products retain considerable moisture near the surface; but there is little data to substantiate such claims.

Recent research conducted at the University of Arkansas has demonstrated that, in addition to reducing WDPT and LDS symptoms, wetting agents may also improve rootzone moisture uniformity and provide more desirable surface soil moisture levels (neither excessively wet/dry) (Fig. A).

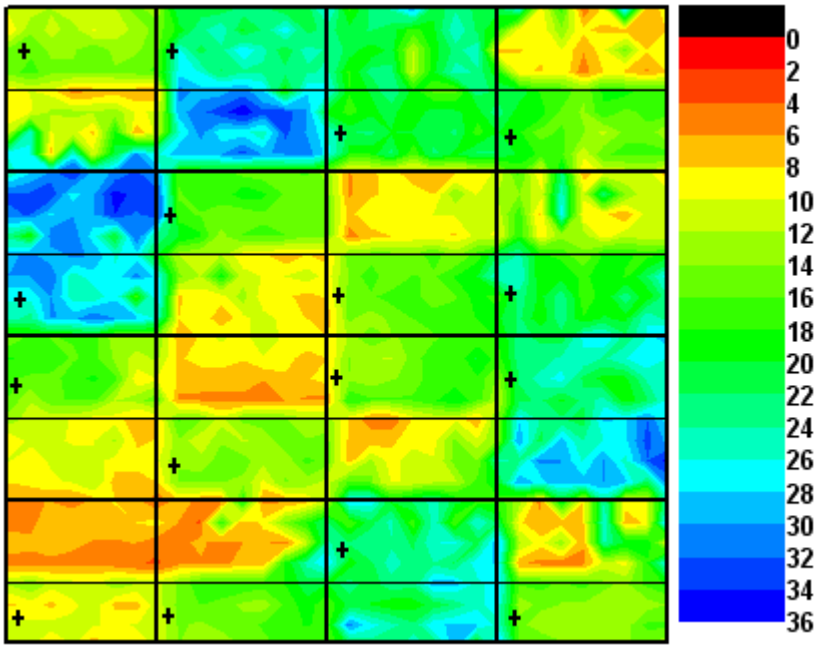

Figure 1. Effect of wetting agent application (+) on soil moisture (0 to 3 inches) distribution in a previous wetting agent trial at the University of Arkansas.

Objective: To determine the effects of various wetting agents on the distribution of soil moisture throughout a sand-based putting green root zone, and LDS incidence, and turf quality.

Methods

Experimental area. The proposed study was conducted on a sand-based putting green at Golf Club Hittfeld E.V. in Hamburg, Germany. The experimental putting green was maintained using practices typical for the region. The study was conducted from May through October in 2011. Irrigation was applied judiciously throughout the study only to avoid severe drought symptoms, so that wetting agent effects may be evaluated across a range of irrigation regimes.

Treatments. The experimental area was sectioned into 1 by 1 m plots for wetting agent treatment application (Table 1). Each treatment was applied to four replicate plots and watered in with 4 mm of water. Treatments were applied monthly from May through September in 2011. Initial treatments were made on 18 May and a second application was made seven days later. Thereafter, treatments were applied at the beginning of each month from June through October. Products were applied using a CO_2 powered boom in a spray volume of 700 L / ha.

Table 1. Wetting agent treatments.

Treatment		Description
1.	Control	Untreated control
2.	Respond (new form.)	20 L / ha

Evaluations. Wetting agent treatment effects were evaluated according to Table 2.

Table 2. Wetting agent trial evaluations.

Evaluation	Description
LDS formation	Plots were visually rated biweekly for the formation of localized dry spot. Data were recorded as a percentage of the plot affected by LDS.
Turf quality	Plots were visually rated biweekly for overall turf quality. Quality was rated on a 1 to 9 scale where 9 = ideal, dense, dark green, uniform turf, 6 = acceptable, and 1 = dead.
Phytotoxicity	Plots were evaluated for phytotoxicity 24 hours following wetting agent application using digital image analysis. Digital images were taken of each plot using an enclosed light box to standardize lighting conditions. Images were analyzed for average color and percent green cover to assess phytotoxicity.
Soil moisture distribution	Soil moisture evaluations were done monthly from July through October. Volumetric soil moisture was evaluated twice monthly using a portable time domain reflectometery (TDR) unit. Measurements were made the morning prior to the next irrigation event. Twenty-five measurements were taken on each plot using a 1 x 1 m grid (20 cm centers) at depths of 3.5, 7.5, and 12 cm. Soil moisture maps were generated for each sampling date and depth (Fig. 1).
Average soil moisture	For each soil moisture evaluation date, the average soil moisture value was calculated from the 25 sub-samples within each plot.
Soil moisture uniformity	For each soil moisture evaluation date, the soil moisture uniformity was calculated as the standard deviation from the 25 sub-samples within each plot.

***Statistical analysis*.** Wetting agent treatments were replicated six times in a randomized complete block design. For each evaluation parameter, an analysis of variance was computed to determine if wetting agent treatment effects are significant ($P < 0.05$). When treatments were significant, wetting agent means were separated using Fisher's least significant difference test ($\alpha = 0.05$). The data were analyzed as a repeated measures experiment, using PROC MIXED of SAS v. 9.1. Date effects were sliced to determine specific dates when significant treatment effects are present.

Results:

The unusually cool and wet weather in Northern Germany during the summer of 2011 limited variable comparisons between wetting agent treatments for soil moisture, turfgrass phytotoxicity, and localized dry spot measurements. However, one of the six sampling dates (17 October 2011) yielded significant differences for soil moisture at the 12 cm sampling depth (Figure 3). No significant differences occurred for localized dry spot, phytoxicity, or turf quality ratings for any of the sampling dates, likely as a result of the unusually cool and damp weather.

It should be noted the statistical difference occurred near the conclusion of the study when the weather finally became drier. However, temperatures were also lower and the likelihood for localized dry spot to occur was minimal. Thus, repeating this study in summer 2012 would potentially yield great differences provided and more common warmer temperatures and drier conditions occur.

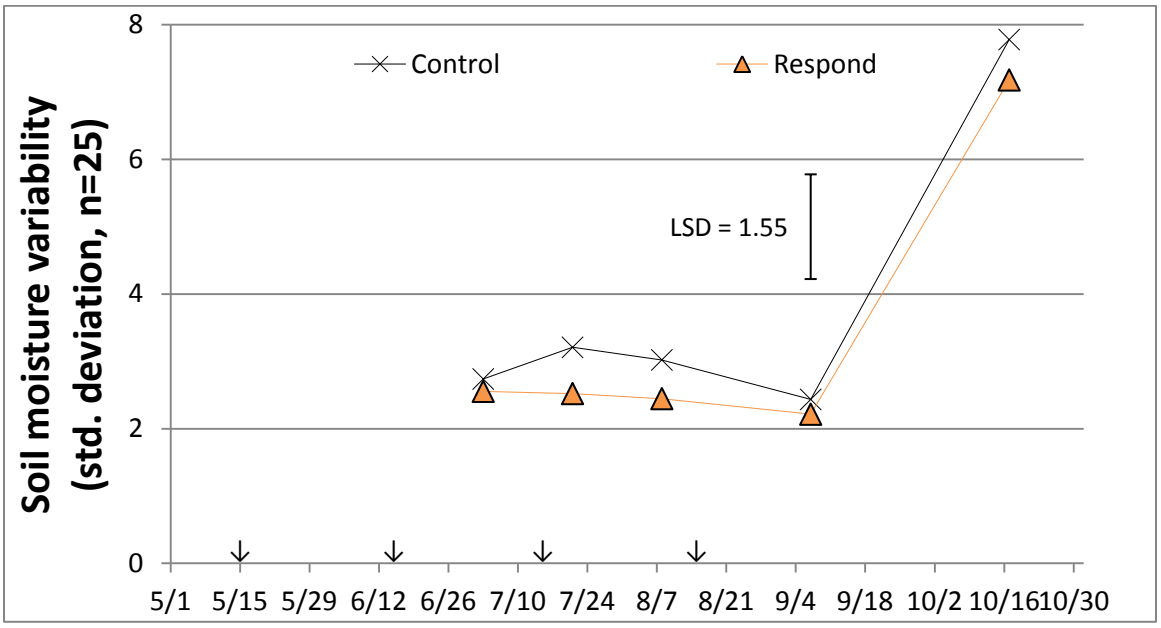

Figure 1. Soil Moisture Variability at 3.8 cm depth, Hamburger Land and Golf Club, Hittfeld Germany, 2011.

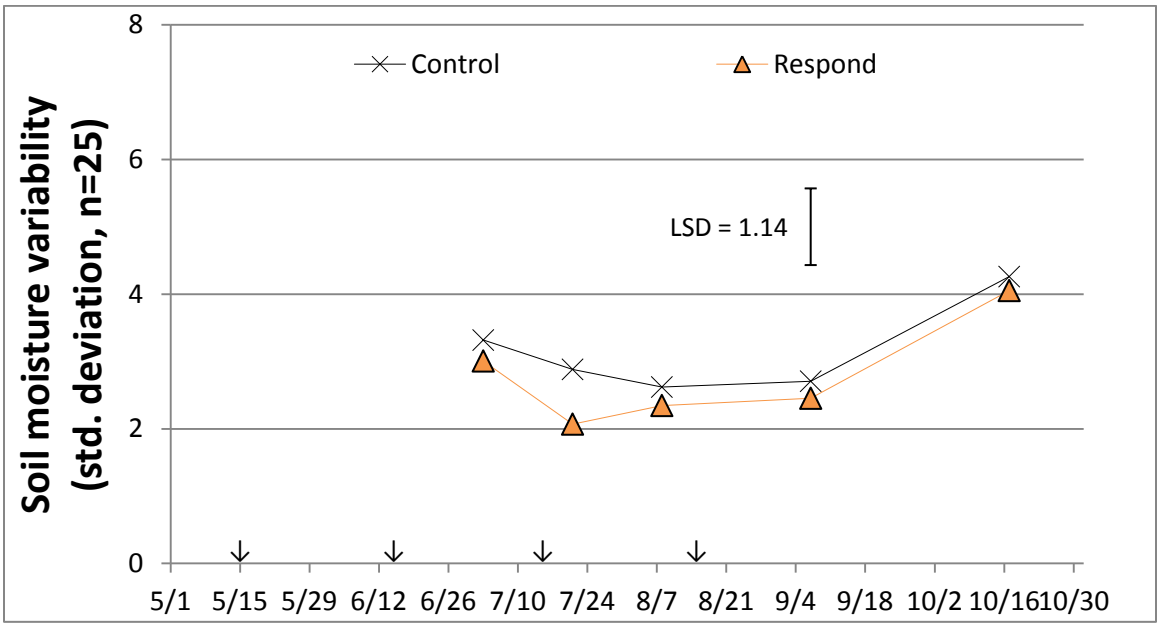

Figure 2. Soil Moisture Variability at 7.6 cm depth, Hamburger Land and Golf Club, Hittfeld Germany, 2011.

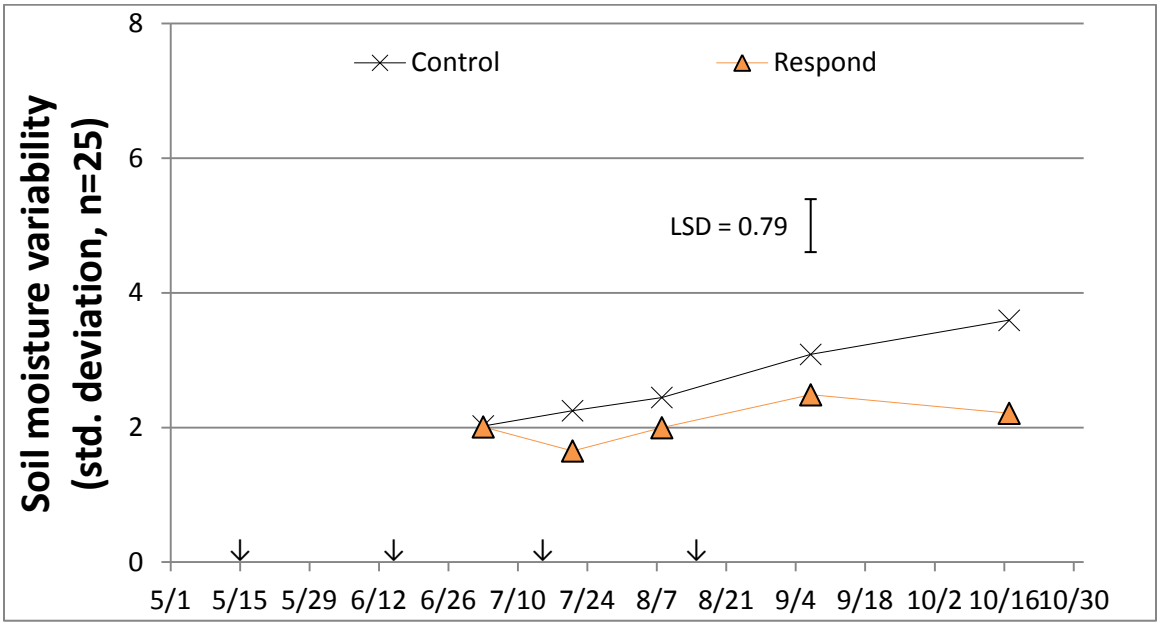

Figure 3. Soil Moisture Variability at 12 cm depth, Hamburger Land and Golf Club, Hittfeld Germany, 2011.

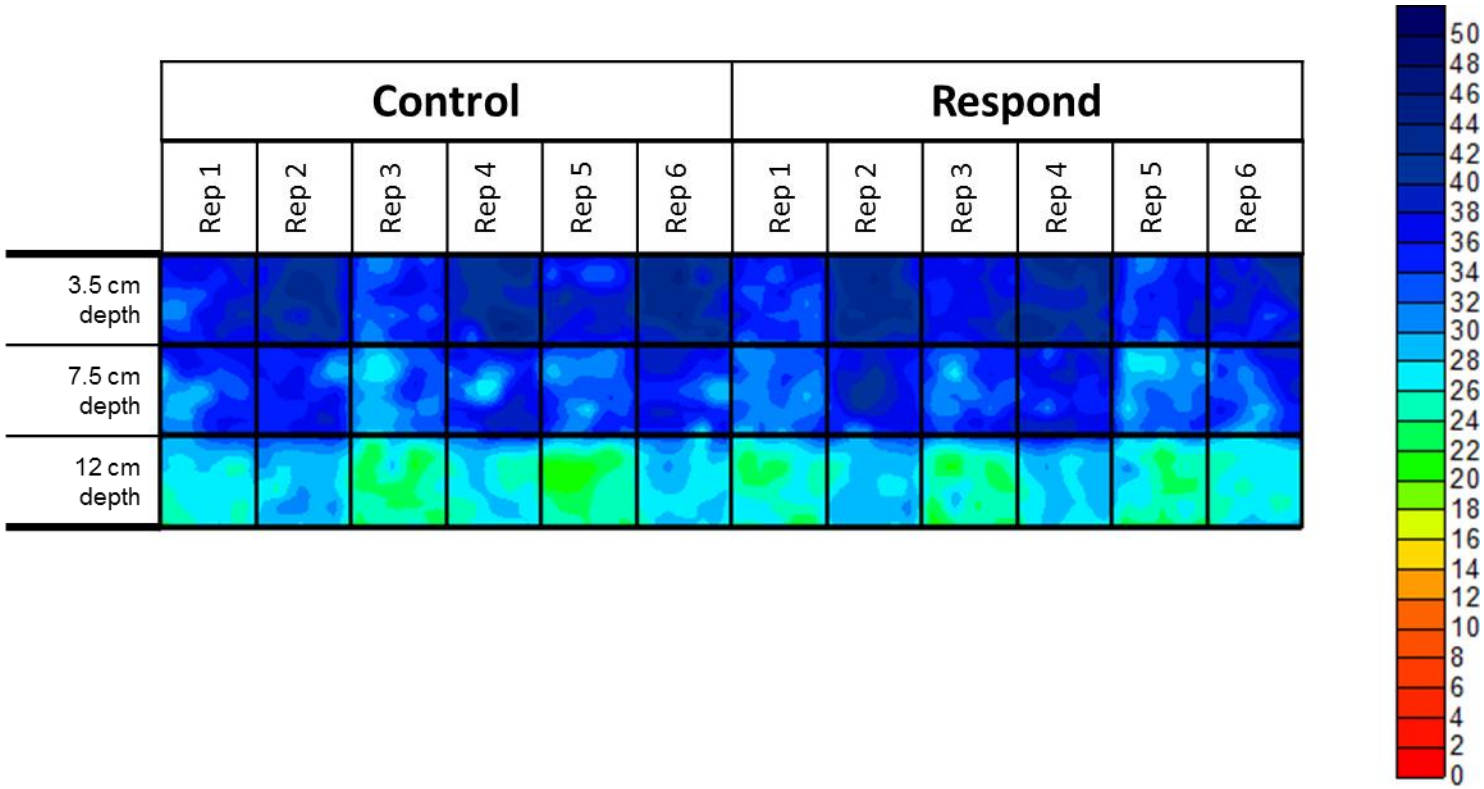

Figure 4. Soil moisture map of plots treated with Respond and untreated plots at three sampling dates. Hamburger Land und Golf Club, Hittfeld, Germany, 3 July 2011.

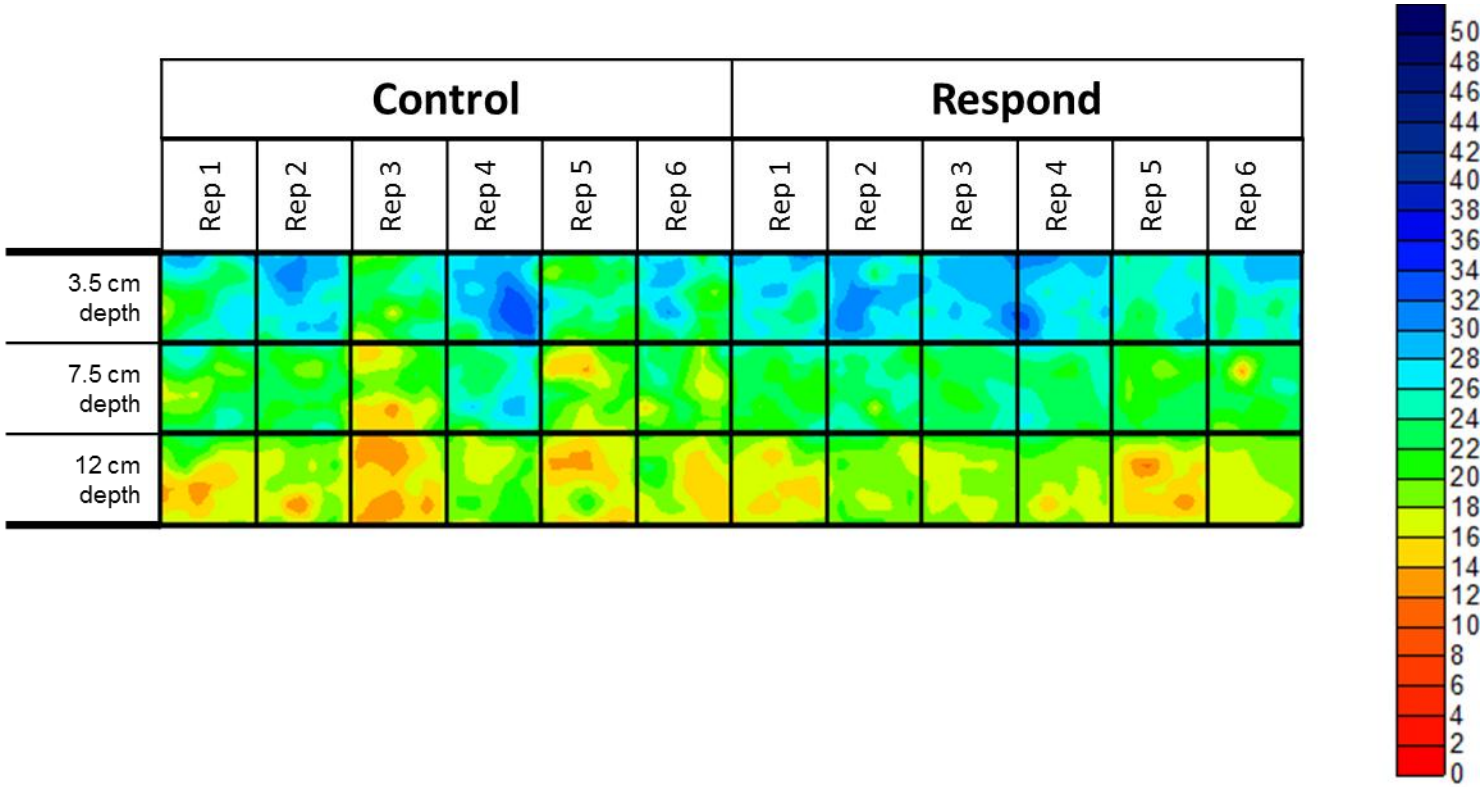

Figure 5. Soil moisture map of plots treated with Respond and untreated plots at three sampling dates. Hamburger Land und Golf Club, Hittfeld, Germany, 21 July 2011.

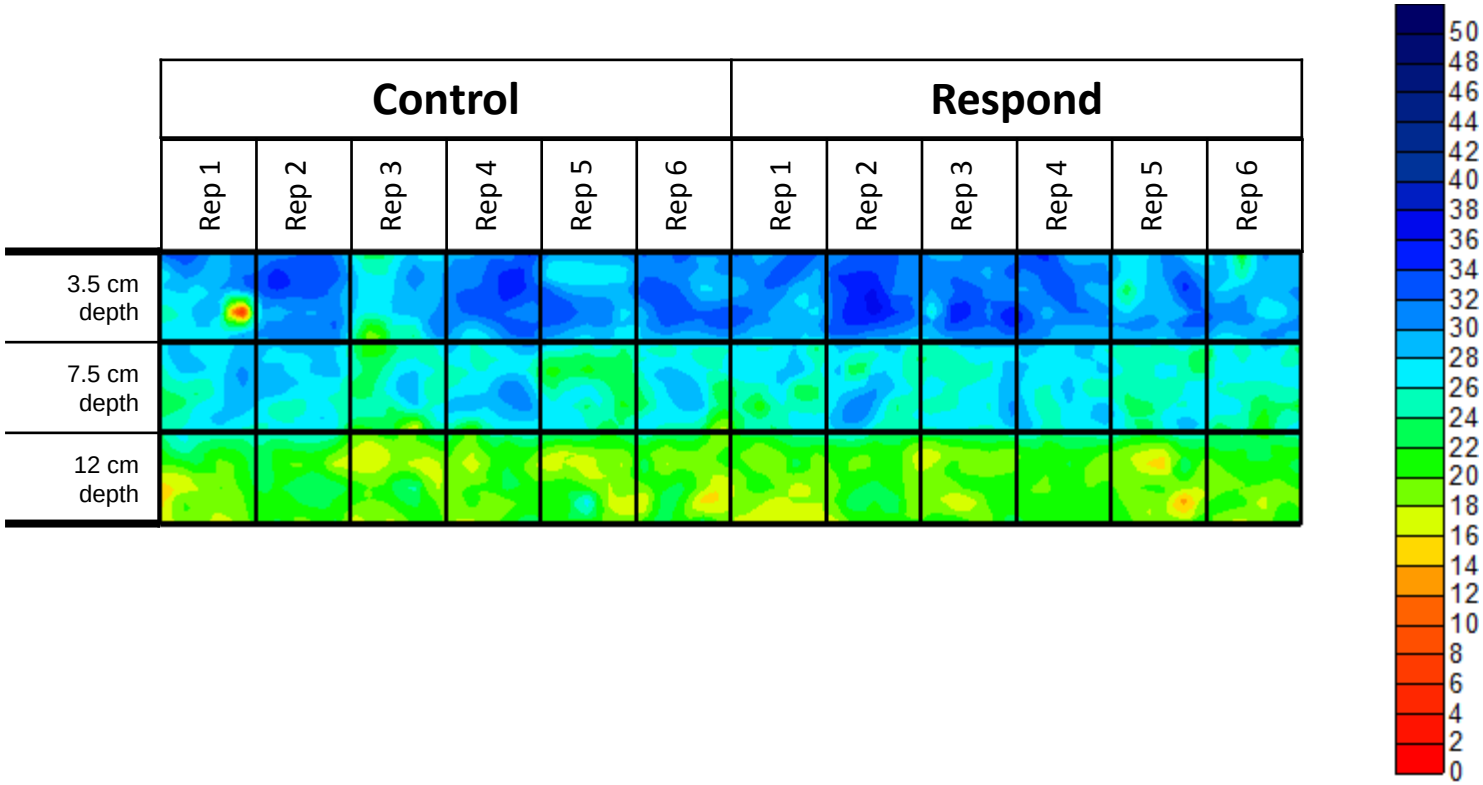

Figure 6. Soil moisture map of plots treated with Respond and untreated plots at three sampling dates. Hamburger Land und Golf Club, Hittfeld, Germany, 8 August 2011.

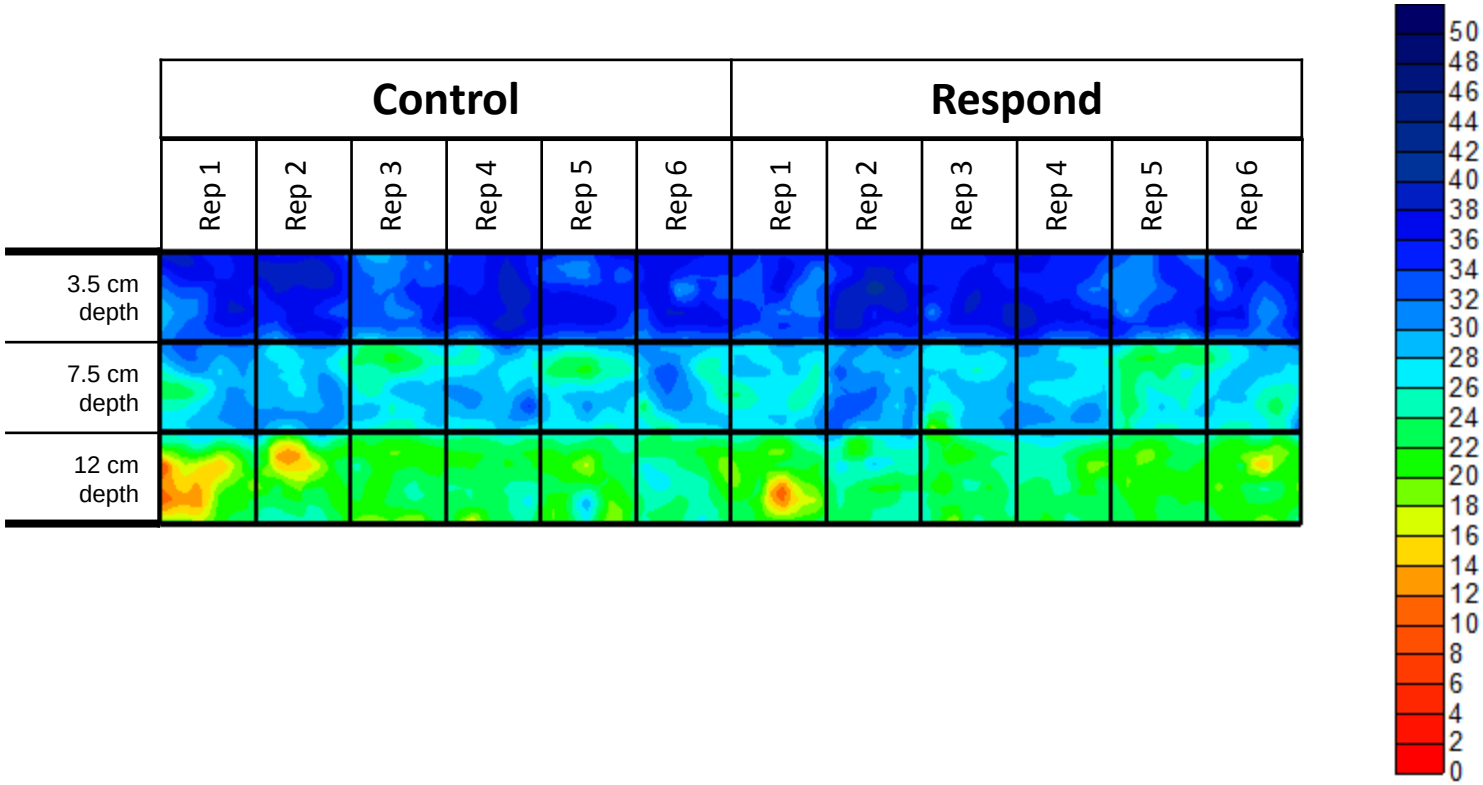

Figure 7. Soil moisture map of plots treated with Respond and untreated plots at three sampling dates. Hamburger Land und Golf Club, Hittfeld, Germany, 7 September 2011.

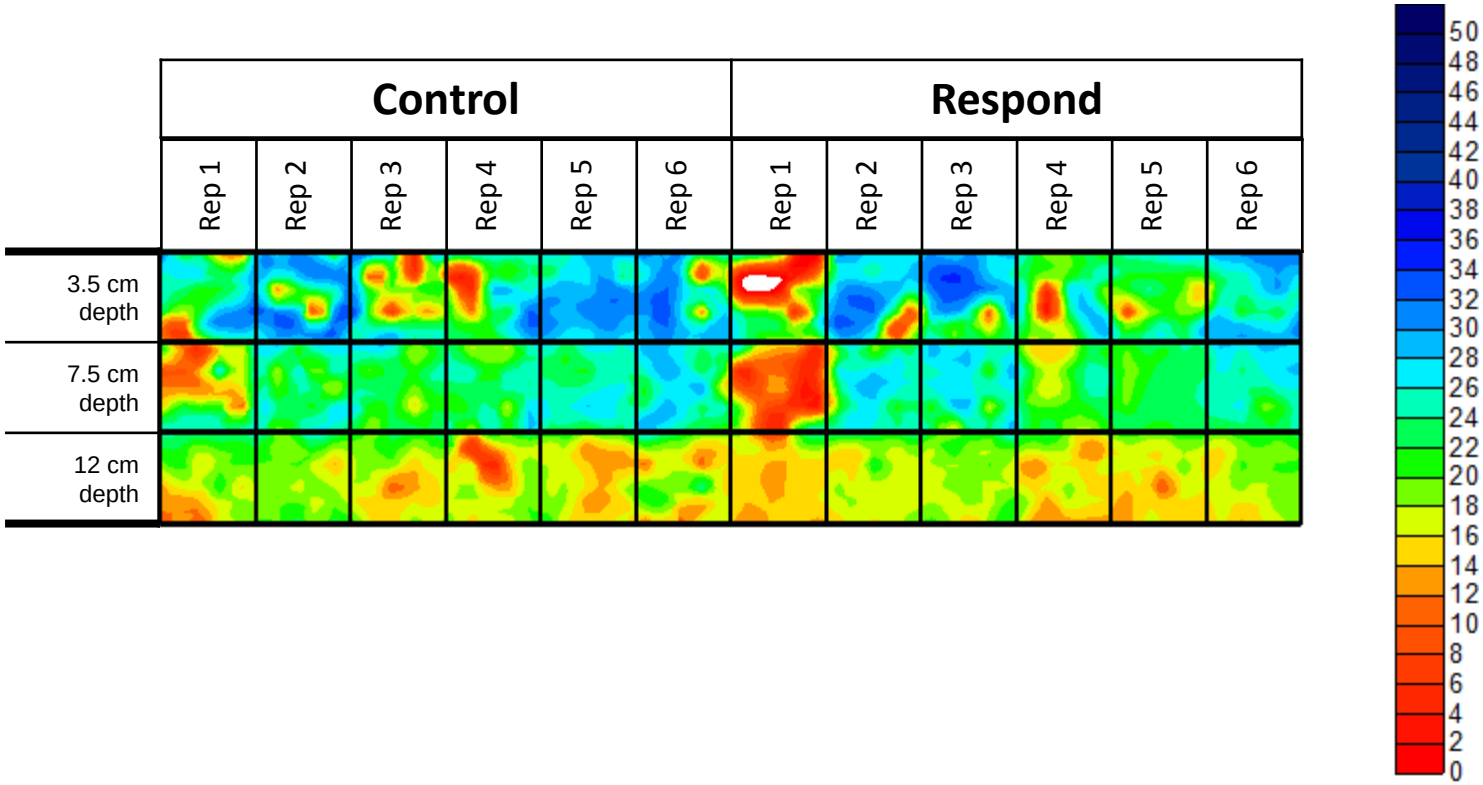

Figure 8. Soil moisture map of plots treated with Respond and untreated plots at three sampling dates. Hamburger Land und Golf Club, Hittfeld, Germany, 17 October 2011.